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Rebirth, devastation and sickness: analysing the role of metaphor in media discourses of nuclear power

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Abstract

Nuclear power plays an important but controversial role in policies to ensure domestic energy security, fuel poverty reduction and the mitigation of climate change. Our article construes the problem of nuclear power in terms of social discourse, language and public choice; specifically examining the role that *metaphors* play in the policy domain. We empirically analyse metaphors as framing devices in nuclear energy policy debates in the United Kingdom between April 2009 and March 2013, thereby capturing the impact of the Fukushima nuclear disaster in 2011. We employ documentary analysis of major UK broadsheet and tabloid newspapers, using electronic bibliographic tools to extract the metaphors. We then map these metaphors using a Type Hierarchy Analysis, which examines how elements of the *target domain* (energy technologies and policies) originate from a different *source domain*. Type hierarchies identify and categorise metaphors, defining the affectual and emotional responses associated with them, providing us with grounded insight into their role in shaping discourse and as a consequence influence public engagement with energy policy. Our analysis highlights three emergent domains of discourse metaphors and discusses the implications of their deployment. The first is Rebirth (the metaphor of Renaissance), contrasting with discourses of Devastation defined through negative-coloured metaphors both from the imagery of The Bomb and those drawn from Biblical and Qur'anic mythology (such as the metaphors of Apocalypse and Inferno), and the third is Sickness drawn from metaphors of health risk domains (Smoking and Addiction).

Keywords: nuclear power; metaphors; type hierarchy analysis; environmental discourse; media coverage; energy policy.

Introduction – nuclear power renewal in the United Kingdom

In the United Kingdom (hereafter UK), the issue of new build nuclear power has become a deeply contentious aspect of energy policy. At current levels of production, nuclear accounts for 20% of the share of the UK's total electricity-generating capacity (MacLeay, Harris, & Annut, 2014). However, the last domestic nuclear power station

Sizewell B was approved in 1985, and the ongoing decommissioning process of the aging reactor fleet will, without new build, likely result in a total reduction in capacity of 75% by 2020 compared to 2002 operating levels (POST, 2003). With growing concern over an energy gap between domestic supply and demand alongside increasing volatility in fossil fuel market prices (for discussion of this issue see Roques, Nuttall, Newbery, & de Neufville, 2006), nuclear is construed in UK policy as a necessary instrument for diversifying the energy mix and thus ensuring security of supply (Peoples, 2014).

Simultaneously, the threat of anthropogenic climate change has spurred the European Union (EU) to act on decarbonising electricity systems to reduce greenhouse gas emissions and thus mitigate climate change-related environmental risks. In the UK, domestic CO_2 emissions reduction targets stemming from the Climate Change Act 2008 are set as legally binding requirements for 80% reduction from a 1990 baseline. Recent EU guidelines indicate measures to create an interim emissions reduction range of approximately 60% in the domestic and commercial power sector by 2030, including the use of nuclear power as a potential decarbonisation technology pathway (Hewicker, Hogan, & Mogren, 2013). These two policy drivers of energy security and climate mitigation have incentivised the "reluctant acceptance" (Bickerstaff, Lorenzoni, Pidgeon, Poortinga, & Simmons, 2008) of new build nuclear leading to something of a "nuclear renaissance", characterised by a growing interest and political acceptance for the construction of new nuclear power facilities in contrast to previous policy measures designed to phase out nuclear capacity (Nuttall, 2004). In the UK this manifested as new nuclear build policy predominantly framed in terms of market-knows-best strategies for encouraging domestic and inward investment (Teräväinen, Lehtonen, & Martiskainen, 2011) alongside the streamlining of planning processes attempting to reduce delays from planning inquiries (Cotton & Devine-Wright, 2012; Johnstone, 2014).

This so-called renaissance has received some support from elements within environmental movements, as potential radiation-related risks from nuclear facilities are framed by some activists and green thinkers as preferable to climate change-related risks (for critical disscusion of this point see Caldicott, 2006). In the UK, notable environmental campaigners including James Lovelock and George Monbiot publicly declared their support, further bolstering the political legitimacy of pro-nuclear policy strategies (Johnstone, 2010; Parson, 2012). Another significant feature of the nuclear renaissance is that pro-nuclear energy policy strategies appeared not to cause significant public opposition from the citizenry of affected countries (including the UK) (Joscow & Parsons, 2012).

With declining citizen and green opposition to nuclear new build strategies the three largest nuclear power producing countries (France, USA and Japan) planned to extend licenses and associated operating lives of most existing plants. Similarly, emergent Southeast Asian economies including China and South Korea began planning increases in nuclear power productive capacity (Choi et al., 2009; Lidsky & Miller, 2002; Zhou, 2010). UK nuclear expansion emerged in spite of persistent public concerns over safety following the 9/11 terrorist attacks and growing international concerns over nuclear weapons proliferation, in part because the UK Government framed these potential security threats as "manageable" within existing regulatory frameworks (Peoples, 2014). However, the 2011 Tōhoku earthquake, tsunami and resultant disaster at the Fukushima-Daiichi nuclear plant in Japan had a deeply significant impact upon the political viability of nuclear renaissance worldwide. In a manner similar to the Chernobyl disaster before, Fukushima has become an iconic

representation of nuclear risk: rooted not only in physical hazards created by leaking reactors, but also in the ways in which this event has altered the nature of *social discourse* around nuclear new build across the world (Hara, 2013; Rieu, 2013).

Nuclear power and social discourse

Nuclear power is subject to multiple public concerns around plant safety, long-term waste management, taxpayer funded clean-up and site decommissioning costs, security threats from spent fuel reprocessing and weapons proliferation. Together these aspects create multifaceted risk discourses, by which we refer to the ensembles of multiple understandings, framings and contexts that lead to the social construction of environmental problems by different policy actors, including politicians, media outlets and civil society organisations (see in particular Dryzek, 1997; Hajer, 1995; Litfin, 1994). The concept of *nuclear discourse* has received considerable attention from communication theorists. Kinsella (2005) in particular argues that nuclear discourse has multiple influences within environmental communication. Discourses may reify political commitment to particular forms of energy generation and weapons production, which in turn produces environmental consequences that become topics for public deliberation (Dalton, Garb, Lovrich, Pierce, & Whiteley, 1999). The claimed successes of nuclear science and technology may then act to influence institutional arrangements of energy policy and consequently legitimate the modernist project of the mastery of nature (Kinsella, 2004), the religious iconography of nuclear arsenals whereby citizens acquiesce to a "priesthood" of nuclear scientists (Chernus, 1989), or else seek to tame other manmade environmental threats, such as those relating to climate change (Bickerstaff et al., 2008).

Discourse analysis is one means to uncover nuclear power's nature as a *sociotechnical* rather than simply technical or scientific problem (Jasanoff & Kim, 2009). This is because, as Wynne (2010) suggests, nuclear power remains *iconically controversial* in the 21st Century, an issue exacerbated by the Fukushima disaster. A significant influencing factor is the media spotlight on global energy production in the wake of the disaster. Global media coverage renewed public awareness of nuclear risks, not only in Japan, but in European nations such as Italy, Germany and the UK (Hasegawa, 2012; Ikegami, 2012; Rieu, 2013). This in turn stimulated an overall decline in public support for new nuclear, with cross-national survey studies showing an immediate and significant lowering of public acceptance across a broad range of advanced economies (Kim, Kim, & Kim, 2013).

The disaster and its communication catalysed the re-emergence of alternative policy discourses or *frames* of nuclear policy (including anti-nuclear and pro-renewable energy frames), particularly in Japan, Germany and Italy (Butler, Parkhill, & Pidgeon, 2011; see also Cotton, 2014). In the UK, however, this effect was less pronounced. A British Science Festival national survey in August 2011 (Populus, 2011) found a slight increase in negative responses to the favourability of nuclear power in the UK (37% very or mainly favourable, 45% mainly or very unfavourable, 27% neutral). It appears that the UK citizenry did not develop strong and persistent anti-nuclear sentiment following the disaster. A global study by Ipsos showed that in Britain there remains a high level of support for nuclear power resulting from an in-built resistance to dependency on other countries and a desire for a mix of energy resources (Ispos Social Research Institute, 2012), further supported by YouGov polling in 2013 that showed that 46% of the British public tend to think that a significant increase in Britain's use of nuclear power would be a good thing, 29% feel it would be a bad thing and a further 25% don't know (Chambers, 2013). In understanding the likely cause of this relatively

high level of public support we must explore the nature of nuclear power discourse as a matter of environmental communication: examining what is (and indeed can be) said about it in public dialogue, and by extension evaluating the way in which language frames energy policy problems (and their respective solutions) thus acting to sustain or overturn the dominant framing of policy positions (see Scrase & Ockwell, 2010).

Language, imagery and the structuring of nuclear discourse

When examining nuclear power as a form of discourse, it is necessary to examine the linguistic representation of the technology and its social and environmental effects. Historically, *negative* imagery is pervasive and grounded in the contentious political and cultural history of nuclear science. Weart's (1988) historical analysis of the imagery of nuclear technology shows how public fears about nuclear power are deeply rooted in a shared cultural consciousness rather than simply engagement with a novel technological solution to energy problems. Nuclear power and the radiation it emits elicit images drawn from age-old beliefs and symbols associated with the concept of *transmutation* (Rosenthal, 1991; Weart, 1988) – the passage through destruction to rebirth (Weart argues that this is archetypally symbolised by the image of the *phoenix*). Images of radiation subsequently proliferated in the popular culture of the 20th and 21st centuries, often represented in the form of "uncanny rays" that transmute the body, bringing hideous death or miraculous new life (North, 1999).

Importantly, the nature of the risk itself is also a matter of imagery evoked within a cultural discourse. If recipients of radiation exposure are not killed then they become irrevocably transformed by the experience, the socio-cultural *invisibility* of these processes makes radiation a "dread risk" – it is unseen, unknowable and characterised not only by suffering but by transmutation (Slovic, 1987). Radiation contaminates rather than merely damages; it pollutes, befouls and taints rather than just creates wreckage (Erikson, 1991). Associations such as radiation sickness, cancer, physical deformities and genetic mutations often come to mind when thinking about radiation risks (Slovic, Layman, & Flynn, 1991). Radiation appears to generate "unnatural" attacks on the human body and in particular the thought of bearing children with radiation-induced birth defects can generate tremendous personal anxiety (Easterling, 1995). Thus, as shown in Slovic et al.'s psychometric work on nuclear risk perception, terms such as "dangerous", "danger", "death" and "pollution" became dominant associations with civilian nuclear technologies (Slovic, Flynn, & Layman, 2000).

The significance of all this nuclear imagery is that such linguistic constructions are important for understanding the way in which public actors (including policy practitioners and "publics") engage with social discourses of nuclear energy policy. As Jaworowski (1999) argues, it is through a variety of cultural forms that nuclear issues enter the public consciousness, often blending fictitious and non-fictitious elements, further backed by psychometric research on nuclear risk shows that fiction and reality often become conflated in cultural consciousness (Peters & Slovic, 1996). One might see a film with a villain threatening to explode atomic bombs in populated cities and then watch the outcomes of Fukushima-Daichii nuclear reactor leaks on the evening news. Within this, mainstream media representations have essential relevance. Empirical media analysis of nuclear power by Gamson and Modigliani (1989), Palfreman (2006) and Doyle (2011), reveal the capacity of mass media communication to directly shape public risk perceptions, attitudes and cultural responses to nuclear power; as well as in shaping the discursive context through which policy decisions on new nuclear come to be accepted or rejected by decision-makers within policy circles.

Informing our analysis of nuclear power and social discourse in the media is a focus upon the use of *metaphors*. Our aim is to investigate how domains of nuclear power metaphors occur in the press, possibly interact, and how they may influence the broader nuclear power discourse. For this purpose, our objectives are to identify reoccurring metaphorical constructs embedded in this social discourse, investigate the frequency of their occurrence over time in a sample of UK newspapers and analyse the cognitive and emotional responses they may stimulate.

Metaphors in environmental communication

Metaphor analysis concerns a type of "linguistic representation that results from the shift in the use of a word or phrase from the context or domain in which it is expected to occur to another context or domain where it is not expected to occur, thereby causing semantic tension" (Charteris-Black, 2004: p. 24). Metaphors are important communicative tools given their "ability to transform the meaning of an established concept… play[ing] an essential role in [our] comprehending aspects of the world that are new or that we do not understand" (Little 2007: 23). Contemporary discussions on the linguistic and cognitive status of metaphors have emerged following the work of Lakoff and Johnson (1980) and, more recently, Núñez (2000). Lakoff and Johnson (1980) assert that metaphors structure the way people think, and that the human conceptual system is fundamentally metaphorical. "Metaphorisation" is thereby the process of transference of one concept onto another; metaphors make humans understand one conceptual domain of experience in terms of another by projecting knowledge about the first familiar domain onto the second more abstract domain. Metaphors therefore greatly affect the perception of the domain onto which it is applied. In environmental communication, specifically, Larson therefore notes that one needs greater sensitivity to the presence and implications of metaphors because individuals rely upon metaphors in their attempts to understand reality and because metaphors are ubiquitous in the science we hear about every day (Larson, 2011).

Nuclear power, as a deeply contentious and politicised (yet poorly understood) sociotechnical issue, and hence highly sensitive to linguistic (and hence metaphorical) framing. The use of certain metaphors within the nuclear energy policy domain creates the conditions by which "particular understandings make some …measures possible while at the same time excluding others … from the options considered appropriate." (Spencer, 2012: p.394). Metaphors therefore directly (if discretely) perform social conditioning, influencing the nature of social discourse about political, environmental and moral acceptability of the technology, and individuals' perceptions of it (see for example Wallis & Nerlich, 2005). Given the important role of citizen actors in shaping nuclear power policy (seen most recently in mass protests against nuclear in Germany and Japan following the Fukushima disaster and causing significant reshaping of energy policy), understanding the role of metaphor in communicative practices and social discourse is of great environmental significance to understanding the future development of the technology, the industry and the range of alternatives technologies and policy options available.

With these facets in mind, we mobilise the concept of *discourse metaphors* in our study: "[the] relatively stable metaphorical mappings that function as a key framing device within a particular discourse over a certain period of time" (Zinken, Hellsten, & Nerlich, 2008). The concept of *discourse metaphors* provides a framework for the cognitive and social study of these linguistic constructions, their implications for policy makers and the ways in which policy decisions are made. This is important, as Jasanoff and Kim (2009) assert, because science and technology policies can only be fully

understood through exploring the deployment of imaginative resources which relate to those policies. Mainstream media coverage is one significant element of this imaginative resource deployment in social discourse, in part due to the ubiquity of popular news publications and their role in communicating metaphorical language.

Materials and methods

We investigate nuclear metaphors deployed in British broadsheet and tabloid newspapers between April 2009 and March 2013 (details of newspaper titles are found in Table 1). The four-year time frame allows us to capture media reporting of the UK's policy shift towards renewed nuclear build across a period when (for example) the 2008 White Paper on nuclear power was implemented (thus spurring the renewed interest in nuclear investment in the private sector) (BERR, 2008), the 2010 election of the Coalition Government (notably where the dominant Coalition partner, the Conservatives, campaigned on the slogan "vote blue, go green"), the Fukushima disaster of 2011, the June 2011 announcement of new sites, and the 2013 announcement of EDF's development of a new reactor at Hinkley Point in Somerset.

Following metaphor identification and trend analysis, we then apply a Type Hierarchy Approach (THA) (Aronson, Harré, & Way, 1995) to the analysis of retrieved metaphors, following the protocol developed by Renzi and Napolitano (2009; see also Renzi & Napolitano, 2011). Previous empirical analysis of metaphor deployment shows, the ways in which their use biases the way in which individuals think, reason, reflect and gather further information on issues (Thibodeau and Boroditsky, 2011). As such, metaphors influence the framing of nuclear power, and in turn can perform social conditioning (Zinken et al., 2008) that will subtly influence citizen conceptions of nuclear power generation policies.

THA asserts that the use of metaphors in connection with a given topic creates a conceptual domain – a certain organisation of human experiences. Different conceptual domains organise experiences, shape individuals' thoughts and language in different ways. The effect on cognitive processes and influence on individuals' framing of approaches to difficult social and policy problems is profound. Thibodeau and Boroditsky's (2011) study of the effect of metaphors on individuals' preference for different crime strategies shows how the metaphoric framing of crime as "a wild beast preying on the city" encouraged survey respondents to put forward policy solutions involving enforcement or punishment, and describing it as a "virus infecting the city" encouraged solutions involving social reforms. Metaphors have a similarly influential effect in the framing of nuclear power policy. In addition to the nuclear imagery mentioned earlier as transmuting and contaminating, we can see other metaphorical links emerging.

Metaphorical domains can generate both positive and negative connotations (sometimes simultaneously, for example the domain of weaponry can be deployed as: "a weapon against climate change" (Jha & Boseley, 2010) or "a time bomb, waiting to explode" (Gamson & Modigliani, 1989). Another example would be the use of metaphors of "rape" and "seduction" (Weart, 2012). In both example, the source domains relate to sex – which are then coloured by domains relating to violence (in the case of rape), and of desirability and manipulation (in the case of seduction) from which metaphorical expressions are drawn. These *source domains* then relate to the *target domain* of "nuclear power": the concept, and the ideas connected to it, being characterised. These connotations and scenarios are generated by interconnected concepts which are associated to the focal term of metaphorical discourse. A THA analysis of "nuclear power" then emerges by conceptual mapping, through a systematic

set of correspondences between constituent elements of the two domains; as a result new concepts are introduced in the target domain that did not exist before the linkage (Way, 1991). This conceptual mapping created by the metaphor, which only partially is made explicit in the language, is then responsible for influencing the shaping of thoughts, attitudes, emotions and, ultimately, actions in connection with the target domain (Hook, 1984). Through the following Type Hierarchies we unmask these conceptual networks and their projection to the domain of nuclear power, revealing how they may impact upon attitudes towards nuclear energy.

Analytical procedure

Our THA analysis involves a two-stage procedure. First, the conceptual network surrounding the metaphorical instance was drawn providing a semantic picture of the source domain with particular attention to those terms conveying positive (hope) or negative (fear) emotional responses and expectations (Nerlich & Halliday, 2007). Second, the corresponding conceptual network in the target domain of nuclear power was drawn, in which all concepts from the source domain were assigned a corresponding concept. The mapping between the two domains was then analysed and implications discussed.

Sampling the newspapers

The selection criteria for the specific newspapers included circulation, area of circulation and, if possible, private ownership. We focused principally on the UK case study. Newspapers were selected that were not predominantly local or regional in scope and therefore, at least to a certain extent, reflected their national public agendas. Priority was given to national broadsheet and tabloid papers as these can be expected to provide the highest amount of coverage on political issues, and to have the highest agenda-setting impact for policy makers and the general public (Barkemeyer, Figge, & Holt, 2013; Carvalho & Burgess, 2005). In addition, three major tabloid newspapers were included in the sample in order to identify similarities and differences in the way in which nuclear energy is framed compared to broadsheet coverage.

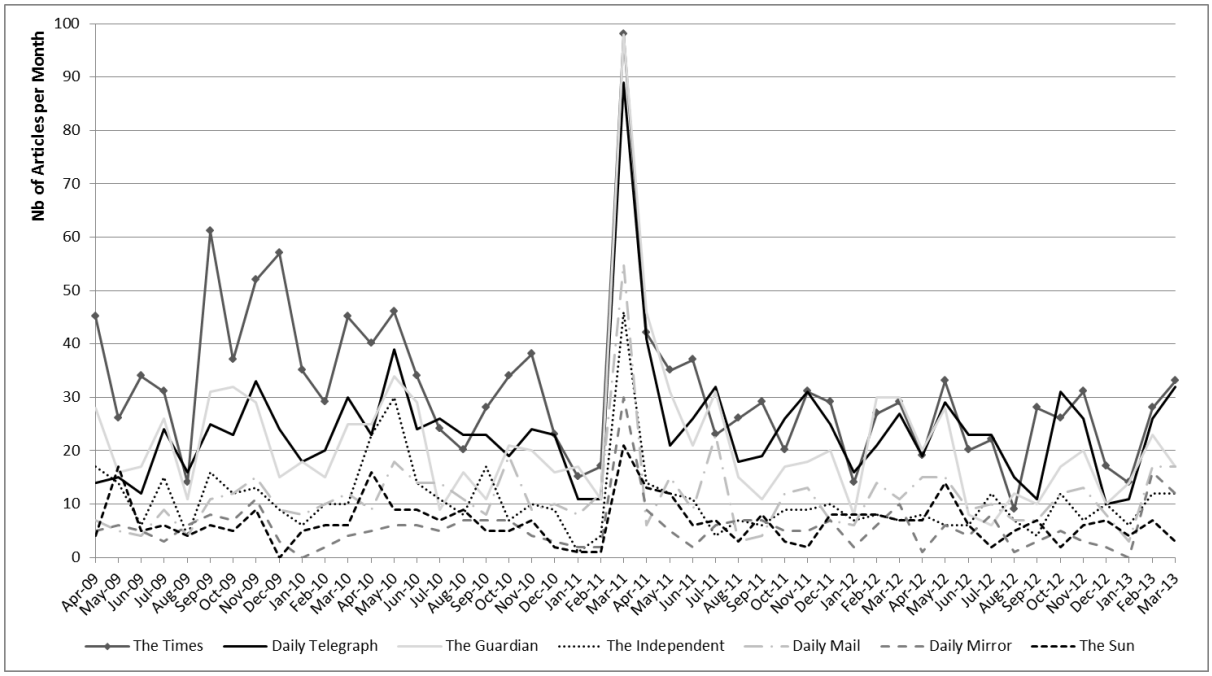
Data were collected using keyword searches of the LexisNexis newspaper archive for each of the seven newspapers. As some of the newspapers add (capitalized) keywords to the original newspaper content in LexisNexis, the following search queries were used to make sure that only articles containing the search terms "nuclear power/ energy"[1] were captured. Table 1 provides an overview of the sample employed for the analysis. Coverage of Fukushima and of nuclear power related issues was clearly higher in broadsheet newspapers with an average number of nuclear energy-related articles per newspaper of up to 31.35 per month (*The Times*), peaking overall at 83 in March 2011 and then dropping back down to levels identified before the Fukushima disaster in April 2011, i.e. only one month after the event. A closer look at UK-level coverage over time (Figure 1) shows that despite similar overarching patterns, clear differences can be identified between individual newspapers. *The Times*, the *Daily Telegraph* and the *Guardian* show above-average coverage levels throughout and the clearest peaks in March 2011, whereas the amount of coverage in *The Independent* is more in line with the tabloid newspapers in the sample.

[1] (((nuclear power) AND NOT ALLCAPS (nuclear power)) OR (ATLEAST2 (nuclear power) AND ALLCAPS (nuclear power))) OR (((nuclear energy) AND NOT ALLCAPS (nuclear energy)) OR (ATLEAST2 (nuclear energy) AND ALLCAPS (nuclear energy)))

Table 1. Sample of UK Newspapers[2]

Title	Country	Type	Circulation 2013*	Total Nb of Articles in Sample	Average Nb of Articles per Month
Daily Telegraph	UK	Broadsheet, centre-right	555,817	1,148	23.92
The Times	UK	Broadsheet, centre-right	399,339	1,505	31.35
The Guardian	UK	Broadsheet, centre-left	204,440	1,033	21.52
The Independent	UK	Broadsheet, centrist	76,802	518	10.79
The Sun	UK	Tabloid, centre-right	2,409,811	320	6.67
Daily Mail	UK	Tabloid, centre-right	1,863,151	549	11.44
Daily Mirror	UK	Tabloid; centre-left	1,058,488	276	5.75

Figure 1. Coverage of Nuclear Power/Energy (Selected UK Broadsheet & Tabloid Newspapers)



[2] Sources: "UK national newspaper sales: Relatively strong performances from Sun and Mirror", Press Gazette, 8; http://www.pressgazette.co.uk/uk-national-newspaper-sales-relatively-strong-performances-sun-and-mirror; http://daten.ivw.eu/index.php

Metaphor identification

A number of computer-assisted techniques can be deployed to identify metaphors within a large corpus of text. Methods for automated identification of metaphors within a sample commonly proceed by identifying the violation of selectional restriction induced by metaphorical expressions (Baumer & Tomlinson, 2008; Shutova, 2010) and other approaches also exist with various degrees of complexity (Neuman et al., 2013). For this study, we used a semi-automated approach in which only lists of words and selected portions of text were manually reviewed. Rapidminer (Mierswa, Wurst, Klinkenberg, Scholz, & Euler, 2006), a development tool for text and data mining, was used to generate term frequency word vectors. More specifically, all words occurring in each document in the corpus were counted, generating a word vector. All document word vectors were then added up to generate a general word vector for the whole corpus. To reduce noise and the search space, Rapidminer components were also used to stem all words, to ignore their case and all stopwords[3] before the word vectors were generated. To further reduce the burden of manual review, a Part of Speech filter was also applied to only consider nouns, adjectives and verbs. Because of the considerably high number of distinct words still resulting from the processing of the Broadsheets corpus (over 40,000), for this source it was decided to only review the words contained in the articles returned by the search including "Fukushima" in the list of keywords.

All words in the final word vector were manually reviewed in a spread sheet. Those words that were likely to have been used in a metaphorical context because their literal meaning is strongly linked to a domain other than nuclear power, were annotated for follow up. Additional words used to analyse the dataset were independently identified from web sources. The Google service for web searches was used to retrieve a list of pages containing the string "nuclear power/Fukushima is like", assuming that the word following the string would be a candidate for commonly used similes/metaphors in the context of nuclear power discourses. Each of the top 20 combinations of search string + following word returned by Google were then searched independently and the results reviewed, to confirm the frequency of their occurrence was significant. The words so identified were then added to the list of terms to follow up. Finally, a MS Excel VBA routine and a Perl script were used to extract, for each word in the list compiled, all the sentences in which it occurred. This was achieved by extracting all the characters between the last full stop preceding (or the start of the file, if applicable) and the first full stop following the word. For each word, the associated list of sentences and, where required for clarity, the full articles containing it were manually reviewed.

This review aimed at identifying all the occurrences of metaphorical use actually referring to nuclear energy. The main limitation of our method to identify metaphors in a large corpus is its likely low recall. Manual review of promising words and, subsequently, of fragments of text containing them is extremely time consuming and there is a high risk of overlooking terms or fragments which are indeed relevant. This difficulty is amplified by the high level of noise we found in the corpus, in which a high proportion of articles had been retrieved because they only mentioned the search term in a different context or, even, metaphorically. However, our approach was well suited to our aim of obtaining high precision results.

[3] Short, grammatical words such as articles.

Table 2. Size of various datasets reviewed

Source	Word vector size	Words considered	Metaphor occurrences
Tabloids	22178	464	29
Broadsheets	13038*	435	50
All newspapers	-	9	276

Table 2 shows the size of the various datasets we obtained. Table 3 lists some of those stemmed words we considered as promising for identifying metaphors in the full documents. Some of the metaphors that we found in the documents we reviewed, in relation with nuclear energy, are listed in Table 4, which also provides frequency information and an example of their actual occurrence in the documents. Here, we have also included the “smoking risk” as a term of a comparison to “nuclear risk”, which is not properly presented as a metaphor in the documents analysed but which may still induce in the reader a range of conceptual mappings and, ultimately, influence attitudes towards the subject. A full list of terms involved in metaphorical occurrences, with their frequencies, is shown in Table 5.

Table 3. List of sample words considered "promising" to identify metaphors

Addict	alcohol	balloon
charm	corner	corrupt
degrade	demon	depress
extortion	…	

Table 4. Frequency of metaphors in the corpus and examples of actual use

Metaphor	**Frequency**	**Example**
Renaissance	258	BRITAIN'S faltering nuclear renaissance will receive a boost this week when Hitachi, the Japanese engineering giant, unveils a £700m takeover of Horizon Nuclear Power.
Genie	8	This accident may prove nothing but could signify everything: the illogical fear that the nuclear genie can never be controlled
Addiction*	12	Lynas visits Chernobyl and says that opposition to the development of cleaner nuclear energy has hastened climate change, ironically, by spreading a fear that has kept the West addicted to fossil fuels.
Inferno	2	Environmental groups warn that if the infernos make it to the exclusion zone, radioactive soil will be thrown up into the air with devastating consequences.
Apocalypse	24	I went inside the ghostly dead zone surrounding the power plant and saw the apocalyptic impact of the radiation leak and the daily struggle for the people who survived the giant wave.
Bomb	21	Spent fuel rods are 'dirty bombs' that could leak waste into the atmosphere
*Smoking***	*6*	*AN INTERNATIONAL expert on nuclear accidents has said that the health risk for people living close to the site of the Japanese disaster in 2011 is less than that from passive smoking.*

*The Addiction metaphors, although used in the nuclear power context, had "fossil fuel" as their target domain.

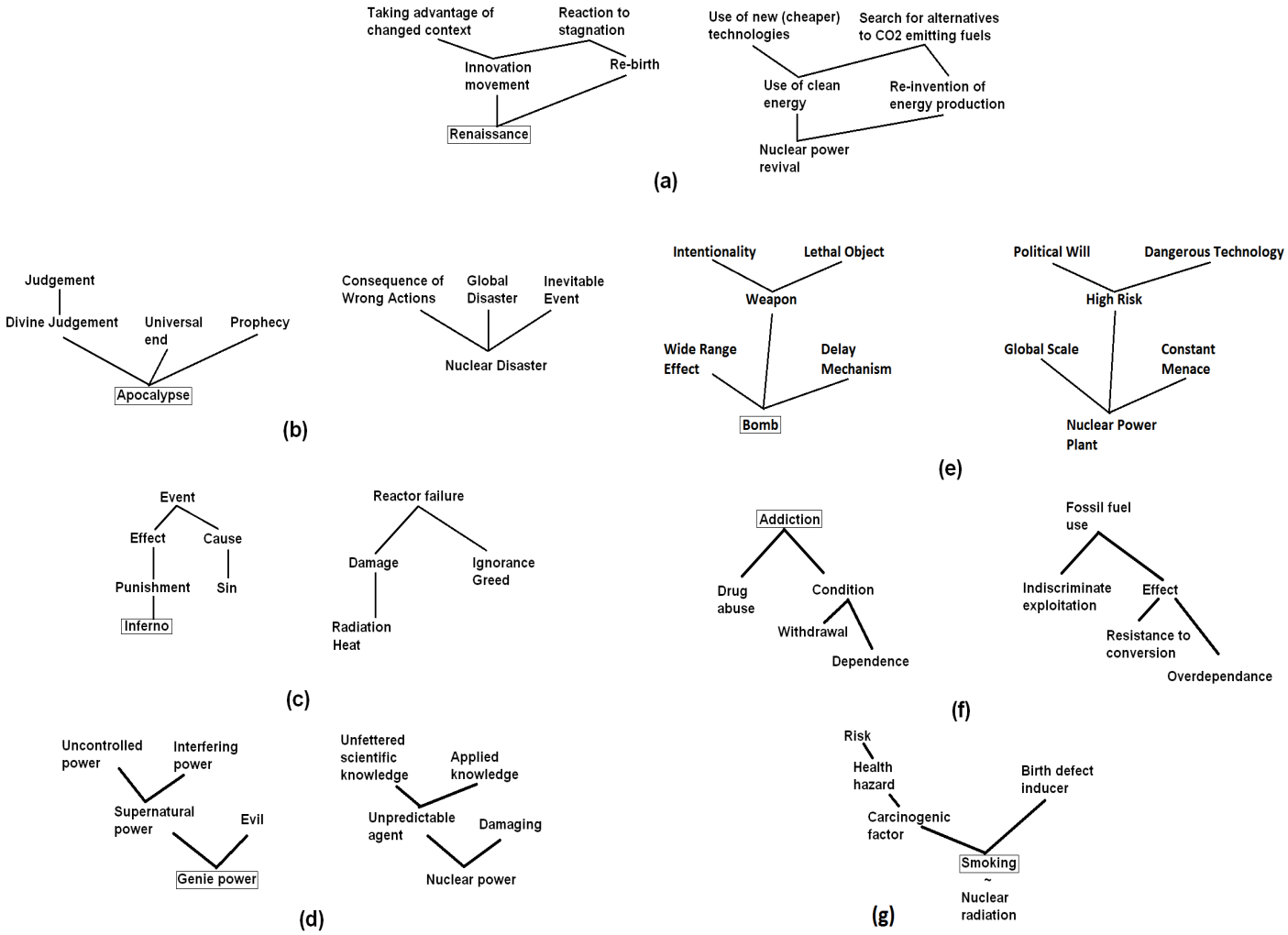
**In the documents reviewed, "smoking" does not properly participate in metaphorical constructs; its occurrence, however, may induce similar mechanisms in the mind of the reader.

Table 5. Full list of metaphorical terms with their frequency

Source domain	**Occurrences**
Renaissance	258
Apocalypse	24
Bomb	21
Addiction	12
Genie	8
Smoking	6
Crusade	6
Russian roulette	5
Spectrum	3

Source domain	**Occurrences**
Bewitch	2
Inferno	2
Suicide	2
Frying pan	1
Religion	1
Revolution	1
Killer	1
Shadow	1
Volcano	1

Figure 2. Source type hierarchies and corresponding mapping to the target domains



Analysis of emergent metaphors

We chose to analyse the type hierarchies predominantly emerging from the most frequent metaphorical terms in Table 5. However, our choice for analysis involved paying attention to the context in which they were used, and their salience to the topic of the source articles (i.e. we focused upon metaphors used in relation to nuclear power, and not just present in the articles but related to other topics). As such we added the term "Inferno" which, although occurring a limited amount of times in the sample of publications explored, was strongly related to the frequent Apocalypse metaphor and the nuclear power context. Within this subset, we found the metaphors could be classified into three different categories: rebirth (Renaissance), Devastation (Apocalypse, Inferno, Genie and Bomb) and Sickness (Addiction and Smoking).

Renaissance

Nuclear Renaissance is a metaphor that draws a positive picture of nuclear energy: simultaneously classic and innovative (Figure 2a). Renaissance is connected to the rebirth aspect of the transmutation imagery mentioned earlier, though now positive in connotation. It is also connected with the idea of progress, advancement, rationality and a *Golden Age*. In other instances it describes positive proliferation: a bloom or blossoming that contrasts with its counterpart metaphor *Dark Age*, which may be mapped to notions of unclean, basic and retrograde energy production activities. Pairing the Renaissance and the Nuclear Power type hierarchies suggests that using nuclear energy will help humanity to respect its resources, which will be available for others to enjoy in the future, keeping our biological systems diverse and productive and advanced. Nuclear power, seen as a form of renaissance, twins rebirth with reinvention in energy production – a second age of nuclear renewal. This rebirth is also a kind of reaction to stagnation, which in this case corresponds to the search for alternatives to CO_2 emitting fuels. Furthermore, innovation might happen when we take advantage of a change of context, in this specific case translating into the availability of new and cheaper technologies. This might lead to an innovation movement to use other forms of non-nuclear low carbon energy sources.

Devastation metaphors

Apocalypse

The metaphor of Apocalypse is very different to that of Renaissance. Synonyms might include terms and phrases such as annihilation, cataclysm, catastrophe, devastation and the end of the world (Figure 2b) - the opposite of good fortune, reinvention, progress and happiness. Exposure to the metaphor may likely influence readers to examine the negative aspects of nuclear energy, in particular at the possibility of incidents or other sudden events which bring great loss and destruction, rather than gradual or invisible risks. It conceptualises nuclear as disaster at a global scale, rather than a persistent leak or point source pollution at a local scale. Specifically, the Apocalypse type hierarchy suggests that a nuclear disaster can be regarded as an inevitable event (prophecy), a worldwide disaster (universal end) which is the direct consequence of wrong actions (divine judgement).

Inferno

In the text examined, the Inferno metaphors refer to an inferno of radiation heat. Yet unlike other metaphors for heat (such as *furnace* for example), the Inferno concept invariably relates to heat as a kind of punishment (emphasising the damage caused, see

Figure 2c), and related to personal vice and sin (ignorance of risk, energy greed). Depicting the radiation heat as an inferno is obviously a form of negative imagery relating to nuclear power technology. Readers of Inferno metaphors may be led to imagine nuclear radiation and Fukushima (or places where nuclear incidents occurred) as a process of torment and punishment for the hubris of nuclear energy. Inferno as a metaphor for hell also expresses the eternal nature of suffering, where the wicked are punished for their sins. The use of such a metaphor in connection with nuclear power has two influences, it may cause people to believe that nuclear energy will transform Earth in a living hell, because of the sins of impious supporters of the technology, and also the long-lasting nature of the threat (the half-live of radioactive materials in the natural environment) is alluded to in the eternal nature of the punishment.

Genie

Genies have twin associations in popular culture. Derived from Islamic mythology, the Genie stems from the Djinn: capricious and often malevolent beings that cannot be controlled (Figure 2d). These features are thus derived from supernatural power. The metaphor of a Genie can promote negative connotations due to their supernatural nature (and hence beyond human control). This seems the intended meaning in the documents we examined. However, considering the popular use of Genie in Western culture, such as within a well-known Disney franchise, nuclear power may also be construed through this metaphor as a powerful solution to the energy problems that humanity can face. We are the master of the Genie (nuclear energy) and we are granted wishes (unlimited power) that will make us happy and rich. Thus, this metaphor may have positive and negative connotations, depending on the way in which it is used and the cultural lens through which individuals' preconceptions of the Genie metaphor structure their cognitive understanding of the energy source.

Bomb

The "bomb" metaphor has special status here, both because a nuclear plant disaster may actually develop into an explosive event and because actual nuclear bombs do exist. As a metaphorical framing, however, *bomb* brings from its literal context the concept of a hostile device usually built for conflict by human beings, to destroy property and other human beings (Figure 2e). A literal bomb causes destruction over a variable range, depending on its power and, once deployed, it may be delayed in its action intentionally (e.g. mines, aircraft-carried bombs, timed bombs) or unintentionally (e.g. unexploded ordnance). Like a weapon, a nuclear power plant may be depicted as a deadly, extremely dangerous artefact with destructive power well beyond its immediate locality. No matter the distance, nobody is safe from the danger of its failure, which may be only a matter of time because its internal, mysterious mechanisms may trigger a disaster at any time without notice. This risk, however, is not a natural, inevitable one such as volcanos or tornadoes: political will has joined forces with dangerous science in a highly risky enterprise for the whole population.

Sickness

Addiction

In the context of energy discourses, the equating of fossil fuel use to addiction may instead induce positive connotations on nuclear power. Emerging concepts (see Figure 2f) are withdrawals and psychological dependence (energy dependence), both deriving from drug abuse (energy abuse). The use of the Addiction metaphor sheds a negative light on the production of energy using fossil fuels. If fossil fuel is addictive,

this means the production of energy from it is the result of a behaviour that we, human beings, keep repeating in spite of the harmful and unfavourable consequences. The use of drugs is characterised by physiological and psychological dependence, withdrawal, anxiety, irritability and in certain cases death. Fossil fuels, thus, will have negative consequences on humanity as any addiction has negative consequences on the addicted individual. By contrast, alternative sources of energy, nuclear included, can only be welcome as the solution to a situation which has only weakening or deadly outcomes.

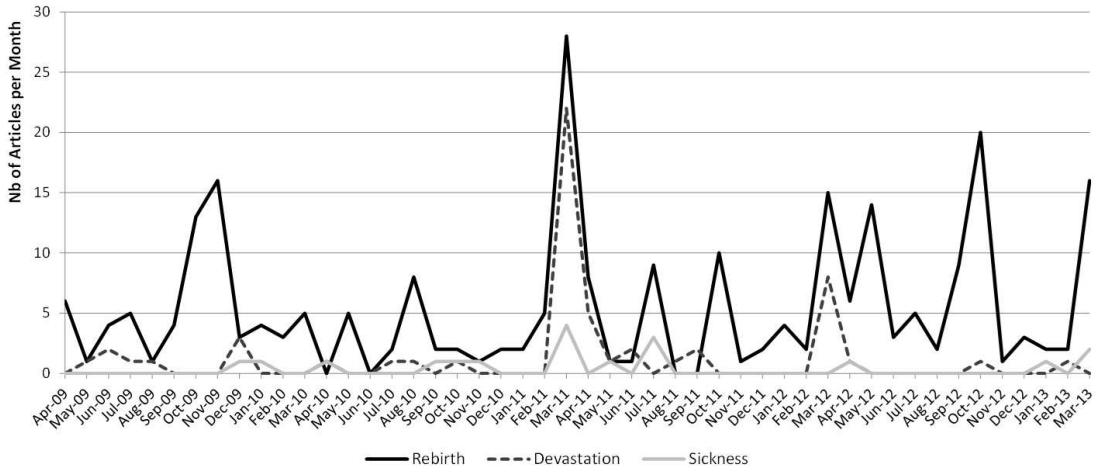
Smoking

Smoking is a known carcinogenic risk that, like nuclear radiation, can cause birth defects and tumours (Figure 2g). In that sense both the source and target domain represent significant health hazards and are presented as implicit risks. However, in the articles we reviewed smoking is mentioned as more dangerous than Fukushima-derived radiation. A similar type hierarchy could be built for other health risks such as obesity or heart disease. Smoking is a habit or a behaviour that intoxicates the body. If we compare nuclear power to smoking we implicitly state that the production of nuclear power intoxicates humanity leading to ill health and possibly death. However, the articles analysed consider nuclear power less dangerous than smoking or being overweight, so this might steer the reader to think that nuclear power might produce an intoxication from which we can recover. In this case the attitude of readers towards nuclear energy is biased towards something which is possible to tolerate. Nuclear Energy is not that "clean" but it does not create the conditions for serious health damage.

Metaphor trends

No clear difference was found in the metaphoric framing of nuclear energy from the pre- to the post-Fukushima era (Figure 3). In particular, the Renaissance metaphor continued to be widely used in the UK newspaper articles after the Fukushima event, with slightly increased frequency, but it changed its valence: instead of being used to talk about the perspective of increased nuclear power exploitation, it was mentioned in reference to nuclear new build plans that were abandoned. The metaphors of Devastation identified here show surges in their frequency in correspondence of the Fukushima event and of its first anniversary. The remaining Sickness-related metaphors do not show any detectable variation in their occurrence before and after the event.

Figure 3. Frequency of occurrences of metaphors in nuclear power discourses, by theme and in the time frame considered (sample of major UK newspapers)



Discussion

Nuclear power has generated socio-culturally embedded fears, not just about physical harm that maims or kills, but an insidious danger that transforms the body, whilst remaining invisible, undetected by human senses. This is significant, as one might consider the different reactions within the media towards the Tohoku earthquake and tsunami, and the Fukushima disaster itself. The official death toll from the natural disaster stands at 15,889 fatalities (National Police Agency of Japan, 2014), compared to 0 reported deaths as a direct influence of the Fukushima disaster (itself a contested figure). And yet, the influence of Fukushima on public perceptions persists despite the comparatively low casualty rate. This is reflected in the trends of media coverage that surround the disaster, and the persistence of Fukushima-related concepts that are brought into the nuclear energy development discourse four years later. When media sources report on nuclear energy they socially construct the technology within embedded cultural and moral values. Metaphors are one significant way in which these values are made explicit, and our unique methodology and analysis aims to show the relevance of metaphorical themes in structuring nuclear power discourses.

Our clearest finding is that the imagery around nuclear follows a similar pattern to that which Weart (1988) identified – where the metaphorical domain of *rebirth* is a dominant theme. However, whereas Weart used the image of the phoenix to describe a process of transmutation (coming through death to new life, based upon the properties of ionizing radiation to alter human DNA) here the term *renaissance,* as a positive reimagining of rebirth, is clearly dominant. The metaphorical domain thus shifts from insidious transmutation of people towards rebirth of an energy industry that was thus far contracting, to develop new growth in the face of climate threats.

The positive imagery of this new form of rebirth metaphor is countered by a strong element of negative imagery grounded predominantly in supernatural and religious source domains – used in this case to imply something beyond the control of human beings. Apocalypse, Inferno and Genie metaphors are all drawn from biblical and Qur'anic mythology, implying revelation, divine judgment, sin, supernatural disaster, and malevolent beings. What is interesting about the media commentary and political rhetoric surrounding the Fukushima disaster is the notion of a black swan event (Taleb, 2007) – a culmination of factors that led to an unforeseen and catastrophic consequence. The confluence of the earthquake, the tsunami, inadequate sea defences, failures of institutional cultures of safety, and technical failures (for example the failure of a back-up generator to power water pumps) were the factors that came together to ultimately produce the disaster (see Shrader-Frechette, 2011 in particular for a critical

discussion of this framing). This confluence of unknown risks (the black swan event) has been interpreted in media discourse using mythological imagery of supernatural forces of malevolence and punishment, which dovetails with this compounded set of risk factors portrayed as an unforeseen and uncontrollable event. The bomb, by contrast, links images of nuclear power with those of nuclear warfare – the destructive capabilities of the atom bomb. In many respects there are links between the Apocalypse and Bomb metaphors. Though "apocalypse" has its etymological root in disclosure, revelation and uncovering truth, in its common Anglo-American usage it has far more destructive (end-of-the-World) connotations. Whereas these can be rooted in supernatural phenomenon, nuclear technologies are the link between human and divine domains of destructive metaphors. The concept of *nuclear apocalypse* is one that emerged in the context of Cold War détente and the possibilities of nuclear fallout either from the actions of war, or from human failure to control nuclear power plants. The bomb metaphor is therefore a mediator between these destructive metaphorical domains – the supernatural and natural (manmade).

The third domain is that related to Sickness. In this regard we draw parallels to Nerlich and Jaspal's (2012) paper on geoengineering metaphors, where The Earth as Patient/Addict was one of the key themes. Here there is a clear overlap in analysis; the notion that human populations abuse or are dependent upon unsustainable energy has parallels to addictive substances in the human body metaphorical domain (recreational drugs and nicotine). Like Thibodeau and Boroditsky's (2011) study of crime metaphors, the concept of patient and addict likely positions the concept of energy policy as something requiring *care* and *intervention* – healing a sick planet through implicit action (implying nuclear power as a form of medicine). In many respects this sharply contrasts with the Devastation domain – as the former emphasises the hubris, destruction and uncontrollability of nuclear, whereas the latter emphasises the controllability and urgency of nuclear intervention into a climate change-threatened global energy system.

It is important to note the possible role that metaphorical language plays in on the media discourse, when the concept of nuclear *renaissance* is the dominant theme. It is perhaps notable that in an era of media coverage of other forms of social renewal (the so-called Arab Spring being one notable example), and concerns over the influence of religious extremism on safety and political security in the West, the use of Old Testament cultural imagery in nuclear policy reporting links this disaster to judgment, hubris and things beyond human control contrasts with the language of intervention, care and medicine as means to solve climate related challenges. By drawing together these different linguistic domains the subtle influence of media discourse around nuclear renewal becomes apparent.

Finally, we suggest that the dominance of the metaphorical domain of Rebirth, supported by that of Sickness as an intervention/climate mitigation strategy in media discourse is a key factor in stimulating and reinforcing public acceptance of nuclear power in the wake of the Fukushima disaster. However, only empirical examination of the specific effects of these metaphors on public preferences through further qualitative and quantitative empirical study with citizens can confirm whether such influence upon public acceptance of nuclear energy policy has emerged.

Future research

We have already mentioned some published efforts in automatic metaphor detection which could be fruitfully adapted and applied to an extension of this study. These techniques may improve the recall of metaphors, enabling the exploitation of an

even more varied corpus of documents. An extension of this study should also include an extended time frame of two more years, possibly examining the correlation of trends with recent political events in the UK. Some more work may also prove fruitful in examining the interactions and the overlapping between metaphorical mappings. This could be set on a more formal methodology foundation, including the exploitation of freely available, machine-readable semantic resources such as WordNet for the automatic expansion of TH nodes.

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